CLAIMS

1. A method of forming a magnetic recording device having a film of magnetisable nanoparticles, which comprises preparing a suspension of magnetisable nanoparticles in a carrier fluid and depositing the said fluid suspension onto a substrate surface as droplets having a volume less than about 1nl to form said film of magnetisable nanoparticles as a dry residue of the deposited fluid suspension.

2. A method in accordance with claim 1, wherein said fluid suspension is deposited onto the substrate using ink jet printing.

3. A method in accordance with claim 1 or claim 2, wherein said magnetic nanoparticles have been formed at least partially within a macromolecular shell.

4. A method in accordance with claim 3, wherein said macromolecular shell is a protein.

5. A method in accordance with claim 4, wherein said protein is apoferritin or DPS

6. A method in accordance with any of claims 3 to 5, wherein said macromolecular shell is subsequently carbonised by subjecting the nanoparticulate film to an elevated temperature above 300°C.

7. A method in accordance with any of claims 3 to 5, wherein said macromolecular shell is subsequently burnt off by pyrolising the nanoparticulate film at a temperature of greater than 500°C.

8. A method in accordance with any preceding claim, wherein the average surface roughness, R_a, of the substrate is less than about 1nm.

9. A method in accordance with any of claims 1 to 7, wherein the average surface roughness, R_a, of the substrate is in the range from about 5nm to about 20nm.

10. A method in accordance with any preceding claim, wherein the substrate is treated to promote the dispersion of the applied suspension of nanoparticles.

11. A method in accordance with claim 10, wherein the treatment comprises chemical, mechanical or radiation treatment.

12. A method in accordance with claim 11, wherein the radiation treatment comprises exposure of the substrate to UV light.

13. A method in accordance with any preceding claim, wherein the film is treated following deposition of the nanoparticles onto the substrate.

14. A method in accordance with claims 13, wherein the film is annealed after deposition of the nanoparticles onto the substrate.

15. A method in accordance with any preceding claim, wherein the film thickness is no greater than 2 particle diameters (including any encapsulating shell) substantially throughout the film.

16. A method in accordance with any preceding claim, wherein discontinuities in the film surface are less than about 13nm in height.

17. A method in accordance with any preceding claim, wherein the magnetic nanoparticles have a diameter (or largest diameter in the case of non-spheroidal particles) of 20nm or less.

18. A method in accordance with any preceding claim wherein the magnetic nanoparticles comprise an alloy of cobalt and platinum.

19. A method in accordance with any preceding claim, wherein the magnetic nanoparticles are encapsulated.

20. A method in accordance with claim 19, wherein the encapsulating material is a protein.

21. A method in accordance with claim 20, wherein said protein is apoferritin or DPS.

22. A method in accordance with any one of claims 19 to 21, wherein the composition of encapsulated nanoparticles is subjected to a microporous membrane filtration step prior to deposition onto the substrate.

23. A method in accordance with claim 22, wherein the pore size of said membrane filter is in the range from 0.02-10μm.

24. A method in accordance with claims 22 or 23, wherein said membrane comprises polyethersulphone or a polyvinylidene.

25. A method in accordance with any preceding claim, wherein the magnetic nanoparticles are subjected to a magnetic fractionation step prior to deposition onto the substrate.

26. A method of forming a magnetisable film, which comprises preparing a suspension of magnetisable nanoparticles, each having been formed at least partially within a protein

shell, in a carrier fluid and depositing the said fluid suspension onto a substrate surface as droplets having a volume less than about 1nl to obtain said magnetisable film on the substrate as a dry residue of the deposited fluid suspension.

27. A method in accordance with claim 26, wherein the fluid suspension is deposited onto the substrate using ink jet printing.

28. A method in accordance with claim 26 or claim 27, wherein said protein shell is subsequently carbonised by subjecting the nanoparticulate film to an elevated temperature above 300°C.

29. A method in accordance with claim 26 or claim 27, wherein said protein shell is subsequently burnt off by pyrolising the nanoparticulate film at a temperature of greater than 500°C.

30. A method in accordance with any of claims 26 to 29, wherein the average surface roughness, R_a, of the substrate is less than about 1nm.

31. A method in accordance with any of claims 26 to 29, wherein the average surface roughness, R_a, of the substrate is in the range from about 5nm to about 20nm.

32. A method in accordance with any of claims 26 to 31, wherein the substrate is treated to promote the dispersion of the applied suspension of nanoparticles.

33. A method in accordance with claim 32, wherein the treatment comprises chemical, mechanical or radiation treatment.

34. A method in accordance with claim 33, wherein the radiation treatment comprises exposure of the substrate to UV light.

35. A method in accordance with any of claims 26 to 34, wherein the film is treated following deposition of the nanoparticles onto the substrate.

36. A method in accordance with claims 35, wherein the film is annealed after deposition of the nanoparticles onto the substrate.

37. A method in accordance with any of claims 26 to 36, wherein the film thickness does not vary by more than about three diameters of the constituent particles (including any encapsulating shell) substantially throughout the film.

38. A method in accordance with any of claims 26 to 37, wherein the average surface roughness, R_a, of the film is not greater than about 3 particle diameters (including any encapsulating shell).

39. A method in accordance with any of claims 26-38, wherein the composition of encapsulated nanoparticles is subjected to a microporous membrane filtration step prior to deposition onto the substrate.

40. A method in accordance with any of claims 26 to 39, wherein the magnetic nanoparticles have a diameter (or largest diameter in the case of non-spheroidal particles) of 20nm or less.

41. A method in accordance with any of claims 26 to 40, wherein the magnetic nanoparticles comprise an alloy of cobalt and platinum.

42. A method in accordance with any of claims 26 to 41, wherein the encapsulating material is a protein.

43. A method in accordance with claim 42, wherein said protein is apoferritin or DPS.

44. A method in accordance with any of claims 26 to 43, wherein the composition of encapsulated nanoparticles is subjected to a microporous membrane filtration step prior to deposition onto the substrate.

45. A method in accordance with claim 44, wherein the pore size of said membrane filter is in the range from 0.02-10μm.

46. A method in accordance with claims 44 or 45, wherein said membrane comprises polyethersulphone or a polyvinylidene.

47. A method in accordance with any of claims 26 to 46, wherein the magnetic nanoparticles are subjected to a magnetic fractionation step prior to deposition onto the substrate.

48. A method of forming a film of inorganic nanoparticles on a substrate, which comprises preparing a suspension of inorganic nanoparticles, each having been formed at least partially within a protein shell, in a carrier fluid and depositing the said fluid suspension onto a substrate surface as droplets having a volume less than about 1nl to obtain said film on the substrate as a dry residue of the deposited fluid suspension.

49. A method in accordance with claim 48, wherein said fluid suspension is deposited onto the substrate using ink jet printing.

50. A method in accordance with claim 48 or claim 49, wherein said protein shell is subsequently carbonised by subjecting the substrate to an elevated temperature above 300°C.

51. A method in accordance with claim 48 or claim 49, wherein said macromolecular shell is subsequently burnt off by pyrolising the nanoparticulate film at a temperature of greater than about 500°C.

52. A method in accordance with any of claims 48 to 51, wherein the average surface roughness, R_a, of the substrate is less than about 1nm.

53. A method in accordance with any of claims 48 to 51, wherein the average surface roughness, R_a, of the substrate is in the range from about 5nm to about 20nm.

54. A method in accordance with any of claims 48 to 53, wherein the substrate is treated to promote the dispersion of the applied suspension of nanoparticles.

55. A method in accordance with claim 54, wherein the treatment comprises chemical, mechanical or radiation treatment.

56. A method in accordance with claim 55, wherein the radiation treatment comprises exposure of the substrate to UV light.

57. A method in accordance with any of claims 48 to 56, wherein the film is treated following deposition of the nanoparticles onto the substrate.

58. A method in accordance with claims 57, wherein the film is annealed after deposition of the nanoparticles onto the substrate.

59. A method in accordance with any of claims 48 to 58, wherein the film thickness does not vary in depth by more than about three diameters of the constituent particles (including any encapsulating shell).

60. A method in accordance with any of claims 48 to 59, wherein the average surface roughness, R_a, of the film is not greater than about 3 particle diameters (including any encapsulating shell).

61. A method in accordance with any of claims 48 to 60, wherein said inorganic nanoparticles comprise magnetic materials or semiconductor materials.

62. A method in accordance with claim 61, wherein said inorganic nanoparticles comprise semiconductor materials.

63. A method in accordance with claim 62, wherein said inorganic nanoparticles are semiconductor nanoparticles comprising CdS, CdSe, CdTe, ZnS, ZnSe, or ZnTe which are encapsulated by apoferritin or DPS.

64. A method in accordance with any of claims 48 to 63, wherein the composition of encapsulated nanoparticles is subjected to a microporous membrane filtration step prior to deposition onto the substrate.

65. A method in accordance with any of claims 48 to 64, wherein the magnetic nanoparticles have a diameter (or largest diameter in the case of non-spheroidal particles) of 20nm or less.

66. A method in accordance with any of claims 48 to 65, wherein said protein shell comprises apoferritin or DPS.

67. A method in accordance with any of claims 48 to 66, wherein the composition of encapsulated nanoparticles is subjected to a microporous membrane filtration step prior to deposition onto the substrate.

68. A method in accordance with claim 67, wherein the pore size of said membrane filter is in the range from 0.02-10μm.

69. A method in accordance with any of claims 67 or 68, wherein said membrane comprises polyethersulphone or a polyvinylidene.

70. A method of forming a protein thin film on the surface of a substrate, said protein thin film having a thickness of less than 10 times the diameter of its constituent protein particles substantially throughout the film, which comprises preparing a suspension of protein particles in a carrier fluid, said protein particles having been subjected to a membrane filtration step, and depositing the said fluid suspension onto a substrate surface as droplets having a volume less than about 1nl to obtain said film on the substrate as a dry residue of the deposited fluid suspension.

71. A method in accordance with claim 70, wherein said fluid suspension is deposited onto the substrate using ink jet printing.

72. A method in accordance with any of claims 70 or 71, wherein the surface roughness, R_a, of the substrate is less than about 1nm.

73. A method in accordance with claim 70 or claim 71, wherein the surface roughness, R_a, of the substrate is in the range from about 5nm to about 20nm.

74. A method in accordance with any of claims 70 to 73, wherein the substrate is treated to promote the dispersion of the applied suspension of protein particles.

75. A method in accordance with claim 74, wherein the treatment comprises chemical, mechanical or radiation treatment.

76. A method in accordance with claim 75, wherein the radiation treatment comprises exposure of the substrate to UV light.

77. A method in accordance with any of claims 70 to 76, wherein the film is treated following deposition of the protein particles onto the substrate.

78. A method in accordance with any of claims 70 to 77, wherein the film is annealed after deposition of the protein particles.

79. A method in accordance with any of claims 70 to 78, wherein the film thickness does not vary in depth by more than three diameters of the constituent protein particles substantially throughout the film.

80. A method in accordance with any of claims 70 to 79, wherein the surface roughness, R_a, of the film is not greater than about 3 particle diameters.

81. A method in accordance with any of claims 70 to 80, wherein said protein is apoferritin or DPS.

82. A method in accordance with any of claims 70 to 81, wherein the composition of protein nanoparticles is subjected to a microporous membrane filtration step prior to deposition onto the substrate.

83. A method in accordance with claim 82, wherein the pore size of said membrane filter is in the range from 0.02-10μm.

84. A method in accordance with claim 82 or claim 83, wherein said membrane comprises polyethersulphone or a polyvinylidene.

85. A magnetic recording device having a film of magnetisable nanoparticles, wherein said nanoparticles have been prepared in a suspension in a carrier fluid and deposited onto a substrate surface as droplets having a volume less than about 1 nl to form said film of magnetisable nanoparticles as a dry residue of the deposited fluid suspension.

86. The magnetic recording device of claim 85, wherein said nanoparticles are deposited onto said substrate by ink jet printing.